This is a digital copy of a book that was preserved for generations on library shelves before it was carefully scanned by Google as part of a project to make the world's books discoverable online.

It has survived long enough for the copyright to expire and the book to enter the public domain. A public domain book is one that was never subject to copyright or whose legal copyright term has expired. Whether a book is in the public domain may vary country to country. Public domain books are our gateways to the past, representing a wealth of history, culture and knowledge that's often difficult to discover.

Marks, notations and other marginalia present in the original volume will appear in this file - a reminder of this book's long journey from the publisher to a library and finally to you.

## Usage guidelines

Google is proud to partner with libraries to digitize public domain materials and make them widely accessible. Public domain books belong to the public and we are merely their custodians. Nevertheless, this work is expensive, so in order to keep providing this resource, we have taken steps to prevent abuse by commercial parties, including placing technical restrictions on automated querying.

We also ask that you:

+ *Make non-commercial use of the files* We designed Google Book Search for use by individuals, and we request that you use these files for personal, non-commercial purposes.
+ *Refrain from automated querying* Do not send automated queries of any sort to Google's system: If you are conducting research on machine translation, optical character recognition or other areas where access to a large amount of text is helpful, please contact us. We encourage the use of public domain materials for these purposes and may be able to help.
+ *Maintain attribution* The Google "watermark" you see on each file is essential for informing people about this project and helping them find additional materials through Google Book Search. Please do not remove it.
+ *Keep it legal* Whatever your use, remember that you are responsible for ensuring that what you are doing is legal. Do not assume that just because we believe a book is in the public domain for users in the United States, that the work is also in the public domain for users in other countries. Whether a book is still in copyright varies from country to country, and we can't offer guidance on whether any specific use of any specific book is allowed. Please do not assume that a book's appearance in Google Book Search means it can be used in any manner anywhere in the world. Copyright infringement liability can be quite severe.

## About Google Book Search

Google's mission is to organize the world's information and to make it universally accessible and useful. Google Book Search helps readers discover the world's books while helping authors and publishers reach new audiences. You can search through the full text of this book on the web at `http://books.google.com/`

HARVARD UNIVERSITY.

LIBRARY

OF THE

MUSEUM OF COMPARATIVE ZOÖLOGY.

36653.

GIFT OF

Author

February 25, 1911.

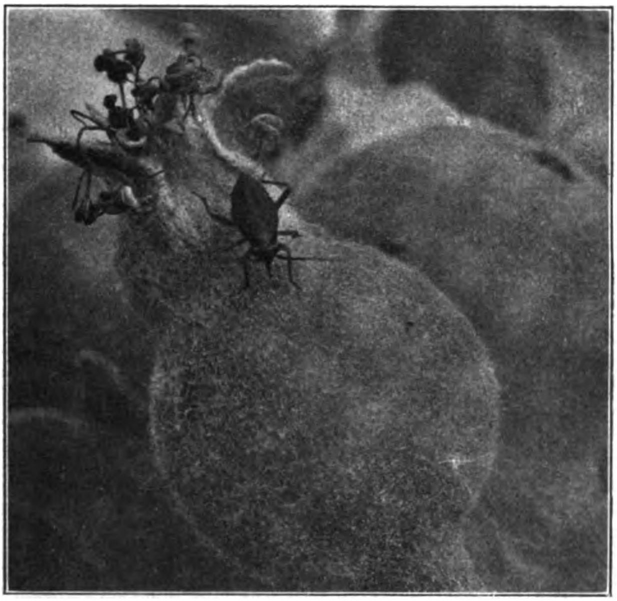
Compliments of the writer

36653

JANUARY, 1911 BULLETIN 291

CORNELL UNIVERSITY
AGRICULTURAL EXPERIMENT STATION OF
THE COLLEGE OF AGRICULTURE
Department of Entomology

# THE APPLE RED BUGS



*Nymph of Apple Red Bug feeding on a young apple.*

By C. R. CROSBY

ITHACA, N. Y.
PUBLISHED BY THE UNIVERSITY

# ORGANIZATION

## OF THE CORNELL UNIVERSITY AGRICULTURAL EXPERIMENT STATION.

## BOARD OF CONTROL
## THE TRUSTEES OF THE UNIVERSITY

### EXPERIMENTING STAFF

LIBERTY H. BAILEY, Director.
ALBERT R. MANN, Secretary.
JOHN HENRY COMSTOCK, Entomology
HENRY H. WING, Animal Husbandry.
JOHN CRAIG, Horticulture.
T. LYTTLETON LYON, Soil Technology.
HERBERT J. WEBBER, Plant-Breeding.
BENJAMIN M. DUGGAR, Plant Physiology.
JOHN L. STONE, Farm Practice.
JAMES E. RICE, Poultry Husbandry
GEORGE W. CAVANAUGH, Chemistry.
ELMER O. FIPPIN, Soil Technology.
WILLIAM A. STOCKING, Jr., Dairy Industry.
HERBERT H. WHETZEL, Plant Pathology.
G. F. WARREN, Farm Management and Farm Crops
CHARLES S. WILSON, Pomology.
GLENN W HERRICK, Entomology.
LOWELL B. JUDSON, Horticulture.
HOWARD W. RILEY, Farm Mechanics.
MERRITT W. HARPER, Animal Husbandry.
JAMES A. BIZZELL, Soil Technology.
CYRUS R. CROSBY, Entomology.
CLARENCE A. ROGERS, Poultry Husbandry.
PAUL J. WHITE, Farm Crops.
DONALD REDDICK, Plant Pathology.
HAROLD E. ROSS, Dairy Industry.
HARRY H. LOVE, Plant-Breeding.
ARTHUR W. GILBERT, Plant-Breeding.
ELMER S. SAVAGE, Animal Husbandry.
E. S. GUTHRIE Buttermaking.
EDWARD R. MINNS, Farm Practice.
PAUL WORK, Horticulture.
LEWIS KNUDSON, Plant Physiology.
K. C. LIVERMORE, Farm Management.
LEE B. COOK, Dairy Industry.
G. WALTER TAILBY, Jr., Animal Husbandry.
HARVEY L. AYRES, Dairy Industry.
CLARA NIXON, Poultry Husbandry.
MORTIER F. BARRUS, Plant Pathology.
LOIS W. WING, Dairy Industry.
EMMONS W. LELAND, Soil Technology
CHARLES T. GREGORY, Plant Pathology.
WALTER W. FISK, Dairy Industry.

The regular bulletins of the Station are sent free to persons residing in New York State who request them.

# THE APPLE RED BUGS

*Heterocordylus malinus* Reut. and *Lygidea mendax* Reut.*
Order, *Hemiptera* Family, *Capsidæ*

## PART I. GENERAL DESCRIPTIVE NOTES

This bulletin treats of two new apple pests. In its preparation free use has been made of the notes and photographs made by the late Prof. M. V. Slingerland, whose observations on these insects began in the spring of 1896. Although these insects were observed on apples at Ithaca from time to time for a number of years, they did not seem to be of sufficient importance to warrant particular study until the spring of 1908, when a serious outbreak was reported in an orchard near Syracuse, N. Y. Prof. Slingerland visited the orchard and in the notes taken at that time wrote, "The injury being done in this orchard is sufficient to warrant a careful study of the life history of this insect, with remedial treatment." During the winter of 1909 he outlined to the writer his plans for carrying out this work, and it is greatly to be regretted that his untimely death prevented its completion.

Considering the importance of the subject and the desirability of placing Prof. Slingerland's observations in permanent form, the writer undertook to carry on the work. During the last two years, co-operative experiments in means of control have been conducted at Ithaca, Syracuse, Brockport, and Waterloo, N. Y. In the spring of 1910 both species were reared in the Insectary at Cornell University and Miss A. C. Stryke has made careful drawings of each stage.

Knotty apples are caused by a number of insects. The Plum Curculio is an old offender and deforms the fruit with its characteristic feeding and egg-laying punctures; Plant Lice or Aphids when abundant cause stunted and misshapen fruit. The injurious work of these insects has long been known and is familiar to every fruit-grower. In 1908, Mr. Judson N. Knapp of Syracuse called Prof. Slingerland's attention to his orchard, in which the fruit was badly deformed, but in such a way that it could not be attributed to either of these well-known pests. The injury in this orchard was very severe, nearly the entire crop of certain varieties being rendered unmarketable.

The culprit was soon identified by Prof. Slingerland as one of the Leaf-bugs which in its immature stages is a brilliant tomato red. More recently we have learned that it is aided in its destructive work by another closely related but entirely distinct species, also of a bright red color. The results of our observations and experiments with these two sucking bugs are here presented in order that fruit-growers may become familiar with these obscure and insidious enemies of the apple and be prepared to fight them whenever they appear in serious numbers.

---

* Described by O. M. Reuter, *Acta Soc. Sci. Fennicæ*, XXXVI, pp. 47, 71. 1909.

## COMMON NAMES

These insects are known among fruit-growers by the highly appropriate name of Red Bugs. As we need names to distinguish the two species, we propose to call the darker form (*H. malinus*) the Apple Red Bug and the lighter colored one (*L. mendax*) the False Apple Red Bug.

## FIRST INDICATION OF THEIR PRESENCE

The eggs of the Red Bug hatch just before the blossoms open; those of the False Red Bug about a week later. Although, while young, the nymphs of both species are a brilliant red, they are hard to find, because of their habit of hiding in between the opening leaves. Some of the inner leaves remain curled lengthwise for several days and the tube thus formed makes a snug retreat for the young bugs. The first indication of their presence is the minute reddish spots on the leaves caused by their feeding punctures (Fig. 87). They usually feed on the upper surface and by making a large number of punctures in a single leaf make their work quite conspicuous.

It is sometimes desirable to determine in advance of the spraying season whether or not an orchard is infested with Red Bugs. If twigs from bearing branches are brought into the house any time after March first and placed in water to force out the buds the Red Bug eggs will hatch soon after the leaves appear. Their presence is indicated by the reddish dots on the leaves caused by their feeding punctures.

## LIFE HISTORY

*The eggs.*—The eggs of both species are laid during late June or early July. They are inserted their full length into the bark on the smaller branches, two-year-old wood being preferred. The eggs are very difficult to find and we have not been able to make as many observations on them as desirable. All eggs definitely known to belong to the Red Bug (*H. malinus*) were found inserted in a slit in the bark at the base of the fruit spurs (Fig. 88). On hatching, the young nymph leaves the embryonic covering protruding from the egg cavity as shown in Fig.

89. As far as we have observed, the normal number of eggs for each cavity is four. Each egg is 1.6 mm. long by .4 mm. wide; it is rather strongly curved, slightly compressed, and dull whitish in color. The embryo developes in the lower enlarged portion, its head being some distance from the tip of the egg. The woody tissue of the bark, especially the outer portion, adheres so closely to the egg that it is impossible to remove it completely even when hardened in alcohol.

The eggs of the False Red Bug (*L. mendax*) are usually inserted in pairs in the lenticels of smooth two-year-old wood. Fig. 90 shows a portion of a small branch bearing two lenticels, each of which contains two eggs. Fig. 91 shows one of the lenticels more greatly enlarged. The eggs are not always placed in lenticels as is shown in Fig. 92. The eggs do not lie parallel to each other, but diverge at a wide angle in order to avoid the solid wood, since they are longer than the thickness of the bark. Fig. 93 shows a section of a twig with an egg in position. The egg is 1.6 mm. long by .4 mm. wide.

The eggs of the Red Bug begin to hatch soon after the leaves of the fruit buds open and hatching is practically complete by the time the blossoms open. The eggs of the False Red Bug hatch about one week later. The spring of 1910 was abnormally early and the first nymphs of the Red Bug were found on April 8 at Ithaca, and Syracuse, N. Y. Mr. B. H. Henion reported finding nymphs on April 9 near Brockport, N. Y.

*The nymphs.*—Both species pass through five immature stages and attain wings at the fifth molt. Under natural conditions, the time required for the nymphs to reach maturity varies considerably with the weather. In the Cornell Insectary, which is heated by steam, the Red Bug required about 35 days and the False Red Bug about 37 days. Under these conditions each stage lasted about one week. A much longer time is required in the orchard.

The young nymphs of the two species are very similar. Those of the False Red Bug may be distinguished by their brighter red color, the absence of dusky markings on the thorax, and by having the body clothed with fine, short, black hairs. The nymphs of this species retain their bright color until full grown, while those of the Red Bug become nearly black on the thorax after the third molt. In the Red Bug nymphs the beak is dusky, while in the other species it is nearly colorless, with a black tip. The immature stages of the Red Bug are shown in figures 81 to 85 and those of the False Red Bug in Fig. 86.

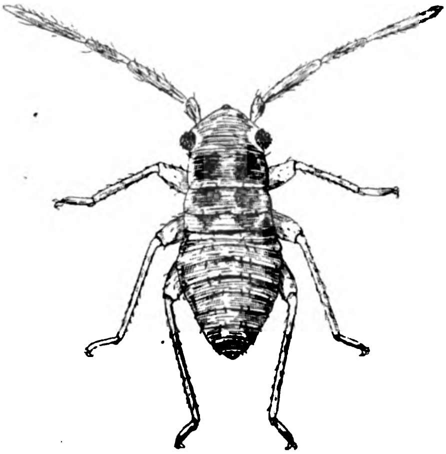


FIG. 81.—*Apple Red Bug nymph. Stage I. Length, 1.2 mm. (See Figs. 82, 83, 84, 85.)*

*Technical description of the nymphs.*—The following descriptions are all taken from living specimens:

(1) *H. malinus.*

Stage I. Length, 1.2 mm. General color a light tomato red. Each segment of the thorax has a large, transverse, medially interrupted, dusky area, the one on the metathorax being smaller than the others and obliquely truncate laterally. Head dusky with two oblique light lines which on the vertex meet the median line of the thorax. Legs, antennae and beak slightly dusky, the antennae yellowish red at the joints. As growth takes place the first and second abdominal segments shorten and the constrictions become deeper. (Fig. 81).

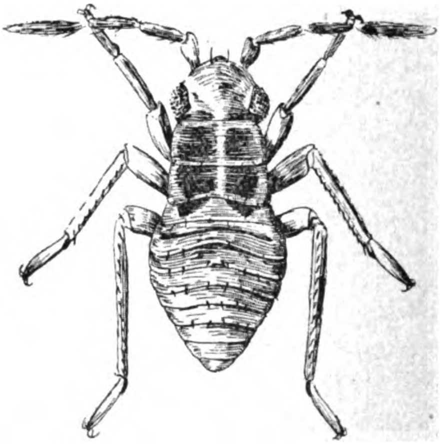


FIG. 82.—*Stage II. Length, 1.7 mm.*

Stage II. Length, 1.7 mm. Head dusky reddish. Thorax with the median line and the posterior margin of the pro- and mesothorax red, the rest dusky over a red ground color. Abdomen tomato red with irregular lighter markings towards the sides; first segment with a broad transverse dusky spot, the second with a smaller one, the next six segments each with a very small spot and the ninth with a large dusky area. Legs and antennae dusky over a red ground color. Beak dusky. Under parts tomato red except a small dark area just above the base of each leg. (Fig. 82).

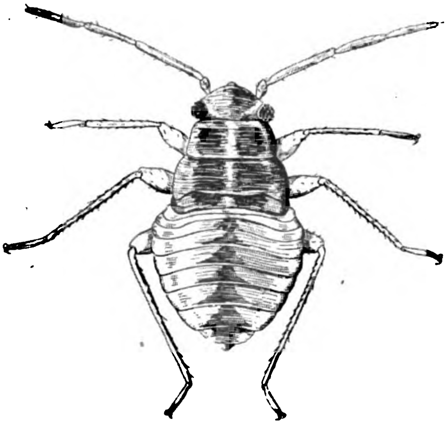


FIG. 83.—*Stage III. Length, 2.2 mm.*

Stage III. Length, 2.2 mm. Head and thorax dull reddish. A small white area below and behind the eye. The wing-pads begin to show on the mesothorax. Abdomen with a median row of dull reddish spots, those on the first, second, and ninth segments the largest. General color of abdomen bright red, variegated with white laterally, the white markings more pronounced anteriorly. Narrow posterior margin of first and second segments white. Antennae dull reddish, lighter at the joints. Legs dull reddish, dusky distally. Beak dusky. (Fig. 83).

Stage IV. Length, 2.5 mm. Head and thorax as in preceding stage except the red is darker and the median line is whitish. Narrow posterior margin of prothorax bright red. The wing-pads extend to the third segment. Abdominal markings as in preceding stage except that the median reddish brown areas are larger and all but the anterior margin of the ninth segment is of this color. Legs, antennae, and beak darker than in the last stage. (Fig. 84).

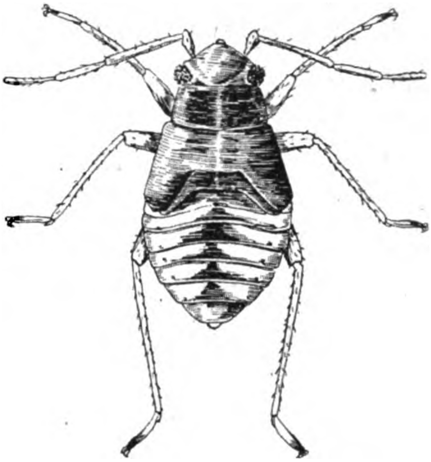


FIG. 84.—*Stage IV. Length, 2.5 mm.*

Stage V. Length, 4.3 mm. Head and thorax dull black over a red ground color. Median line of thorax whitish. First and second abdominal segments nearly black over reddish, posterior margin of each white; third to eighth segments light red variegated with lighter markings and there is a median longitudinal row of large transverse reddish black spots. Ninth and tenth segments reddish black except the red anterior margin. Legs and antennae nearly black with a reddish ground color. Abdomen beneath lighter red with a submarginal row of small black spots; ninth ventral segment nearly covered by a large black spot; a smaller one on the eighth (Figs. 85 and 94).

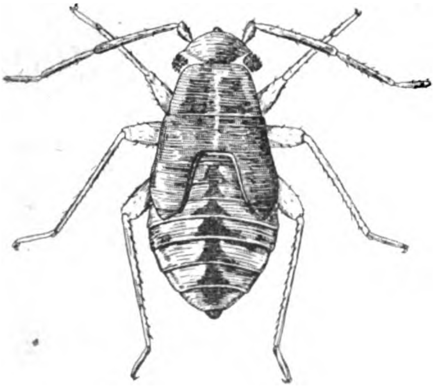
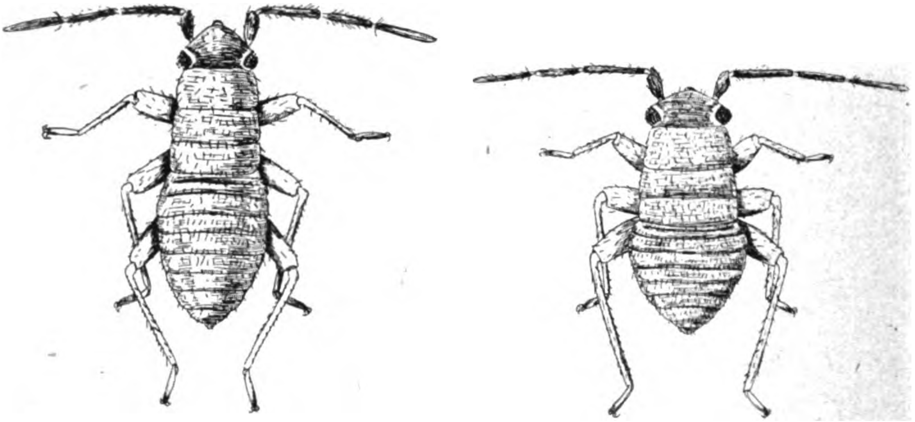


FIG. 85.—*Length, 4.3 mm.*

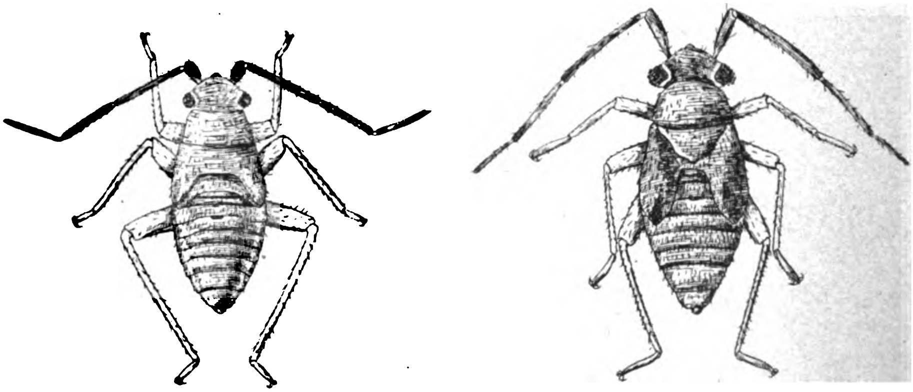
(2) *L. mendax.*

Stage I. Length, 1.5 mm. General color tomato red. A distinct whitish ring around eye. Thorax slightly dusky over a red ground color. Legs dusky, antennae brownish, beak colorless, with the tip black. Whole dorsal surface clothed with short stiff black hairs.



*Stage II. Length, 2.5 mm.*

*Stage III. Length, 2.7 mm.*



*Stage IV. Length, 3.25 mm.*

*Stage V. Length, 4 mm.*

FIG. 86.—*Immature stages of the False Apple Red Bug.*

Stage II. Length, 2.5 mm. Very similar to last stage. Antennae dusky brown, last segment lighter except at base. Tylus dark.

Stage III. Length, 2.7 mm. The wing-pads just begin to show on the mesothorax. Coxae tomato red, rest of legs and beak translucent, slightly dusky; posterior tibiae brownish. Tylus dark brown. Legs clothed with stiff black hairs.

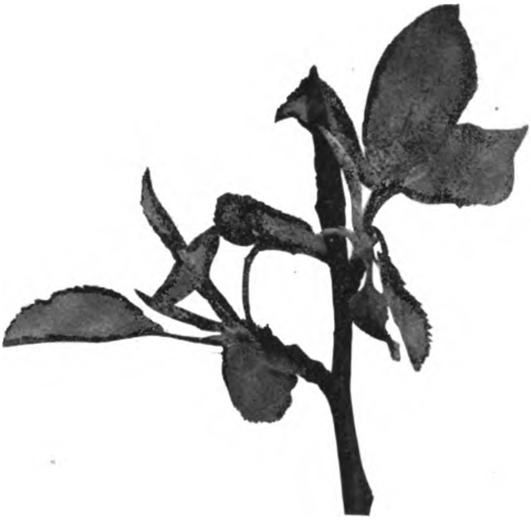


FIG. 87.—*Reddish dots caused by punctures of the False Apple Red Bug.*

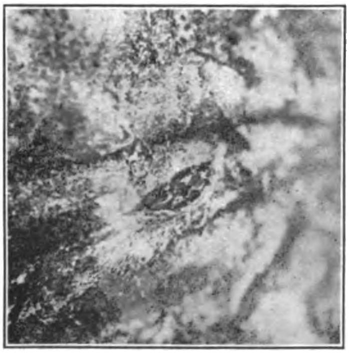


FIG. 88.—*Eggs of Apple Red Bug at base of fruit spur.*
(Photo by V. I. Safro)

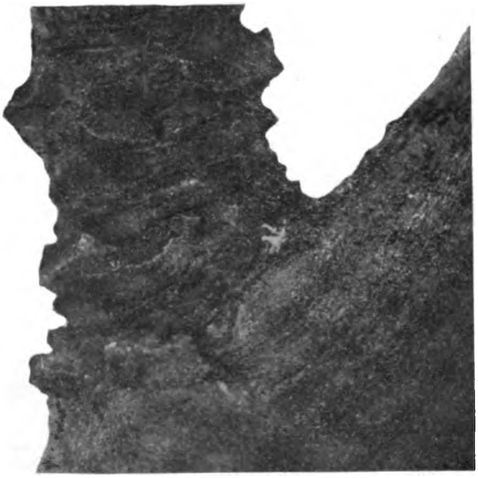


FIG. 89.—*Embryonic covering protruding from the egg cavity after hatching of the Apple Red Bug.*

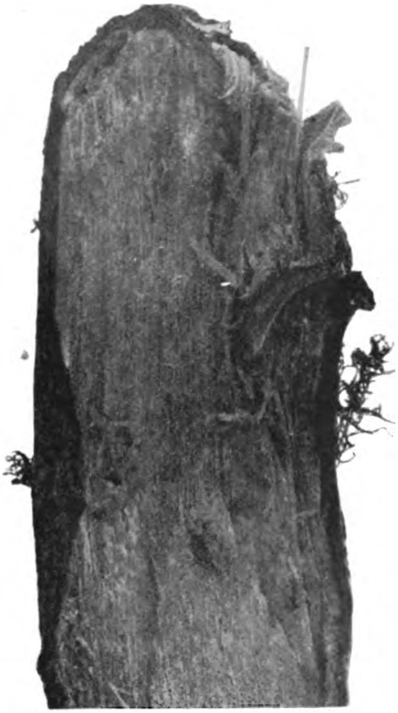


**Fig. 93.**—*Section of twig showing egg of False Apple Red Bug in position.*

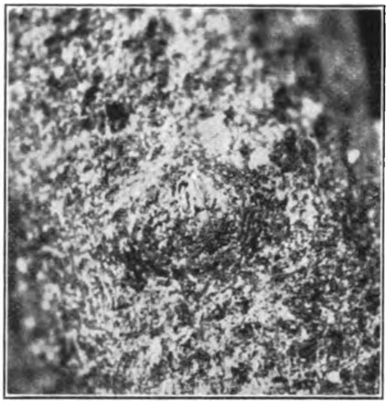


**Fig. 91.**—*Lenticel of apple twig in which are inserted two eggs of the False Apple Red Bug. Greatly enlarged.*

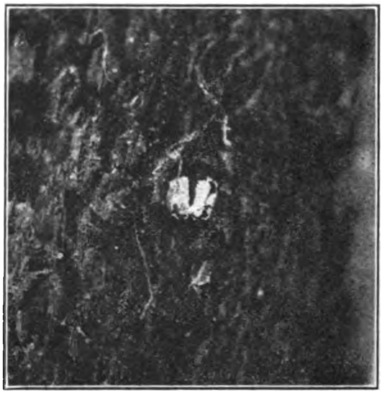


**Fig. 92.**—*Two eggs of the False Apple Red Bug not inserted in a lenticel.*

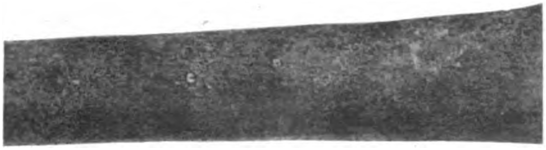


**Fig. 90.**—*Eggs of False Apple Red Bug in two-year-old apple twig.*

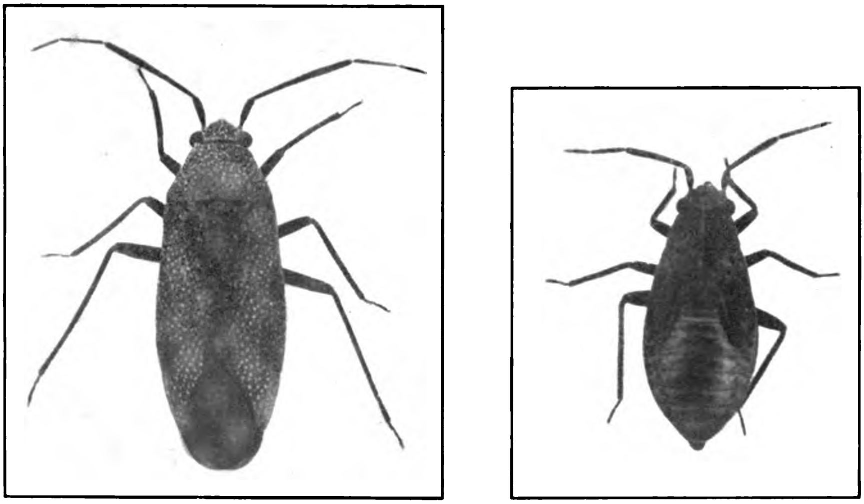


FIG. 94.—*Apple Red Bug. Adult and fifth stage nymph.*

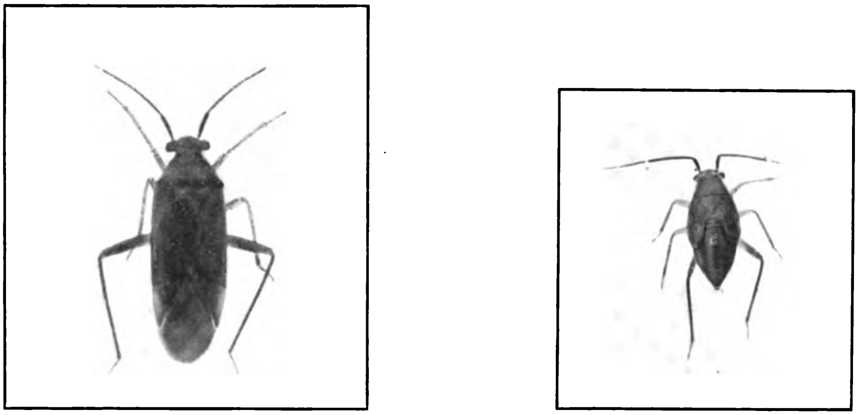


FIG. 95.—*False Apple Red Bug. Adult and fifth stage nymph.*

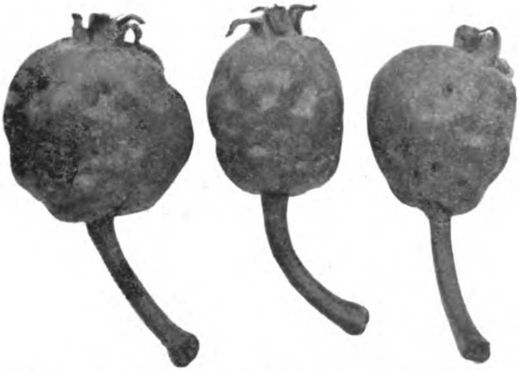


FIG. 96.—*Small apples deformed by Red Bug punctures.*

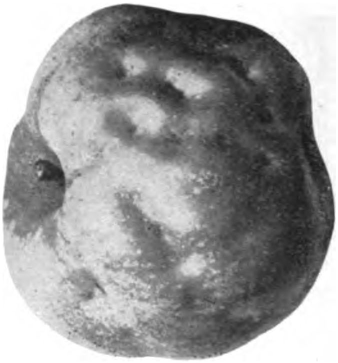


FIG. 97.—*Mature apple, showing injury by Red Bugs.*

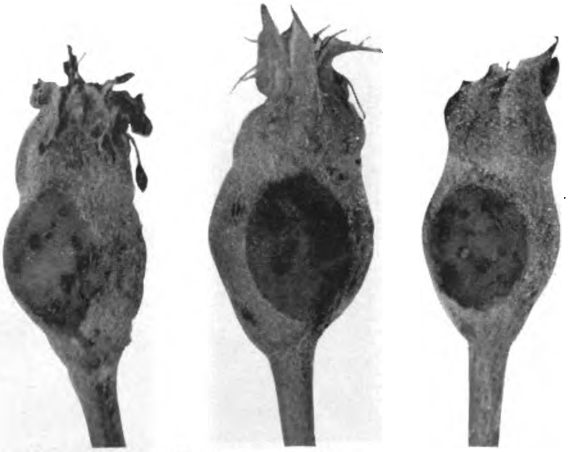


FIG. 98.—*Small apples cut open to show discolored areas around the punctures.*

Stage IV. Length, 3.25 mm. Very similar to last stage in color. The wing-pads extend nearly to the posterior margin of the second abdominal segment.

Stage V. Length, 4 mm. Wing-pads extend to fifth abdominal segment. General color bright tomato red, tip of wing-pads and line along scutellum dusky. Legs dusky, darker towards the tip. Antennae dusky, nearly black; last segment brownish at base. Tylus jet black. Last two abdominal segments with a broad median dusky mark on the dorsum. Whole body clothed with short, fine, black hairs (Figs. 86 and 95.

*The adult.*—The adult Red Bug (*H. malinus*) is about ¼ inch long (Fig. 94). The general color varies from red to nearly black; usually the thorax is black in front and red behind. The wings are red, usually black along the inner edge and with a pointed ovate black spot near the outer margin. The scuteltum, legs and antennae are black; the eyes, dark red. The entire dorsal surface is sparsely clothed with conspicuous white, flattened, scale-like hairs.

The adult False Red Bug (*L. mendax*) is of about the same size as the preceding species, but the general color is lighter and the white, scale-like hairs are lacking (Fig. 95). The head and prothorax are orange red, the latter with a narrow black posterior border. The scutellum is orange red in front and blackish posteriorly. The wings have a band of orange red along the outer edge; the inner part is dusky. The amount of red on the wings varies greatly in different individuals; in some they are almost entirely reddish, in others dusky. The eyes are dark red; the antennae black; the legs dusky yellow, darker towards the tip.

## HABITS OF THE NYMPHS

Very soon after hatching the nymphs move to the young leaves on which they feed until full grown in case fruit is not available. In the Insectary we have reared both species to the adult stage exclusively on foliage. Usually when fruit is present the nymphs attack it as soon as set and sting it to death with their feeding punctures. As they grow older they become more active, and when disturbed retreat to the twig where they adroitly dodge to the opposite side like a squirrel. When frightened they frequently drop from the branch but rarely fall to the ground, usually alighting on another branch. They have a curious way of getting a new hold on a branch or leaf. The posterior end of the alimentary canal can be extruded and is covered with a viscid secretion. As soon as the insect strikes an object in falling the sticky organ adheres to it until a foothold can be obtained. When confined in a glass bottle young nymphs become attached to the glass so firmly in this way that they cannot escape and so perish.

### HABITS OF THE ADULTS

Even in a badly infested orchard in which the crop has been practically ruined it was very difficult to capture the adults. They dodge to the opposite side of the branch at the slightest alarm and then suddenly take flight.

The laying of the eggs has not been observed but probably takes place during June and July; in the case of the False Red Bug it may be deferred till September.

### INJURY TO THE FRUIT

While the most conspicuous work of the Red Bug is found on the leaves, this damage is very slight. Those leaves which are badly punctured early in the season become curled and in some cases may drop off. (Fig. 100). A little later the bugs attack the tender leaves at the tips of the growing branches and frequently stop growth by their punctures. The principal injury, however, is caused by the punctures in the young fruit. The apples are then very small and the four sharp bristles of the bug's beak penetrate quite to the center. The picture on the cover shows a nymph feeding on a young apple and is from a photograph taken by Prof. Slingerland. The plant tissue around each puncture becomes discolored and hardens (Fig. 98). Many of the punctured apples fall to the ground, others dry up on the trees, while the remainder mature but are badly deformed and rendered unmarketable (Figs. 96 and 97). Sometimes a drop of gum oozes from each puncture (Fig. 99).

When first reported in the Syracuse orchard, the injury was principally confined to the Greenings but recently the Red Bugs have attacked the Pound Sweets, Ben Davis and Spies. In 1908 the injury in the Syracuse orchard amounted to 25% of the crop. In the same year the entire crop of Greenings in the Frear orchard near Ithaca was destroyed. Nearly all the young apples of this variety were punctured and dropped early in the season. Other varieties in the same orchard were only slightly injured. Mr. D. B. Weaver of Waterloo, N. Y., states that during past years the injury in his orchard has amounted to about $1,000 a year. Mr. B. H. Henion of Brockport estimates his yearly loss at $300 to $500. In 1909 the presence of Aphids in great numbers made any estimate of the extent of Red Bug injury almost impossible.

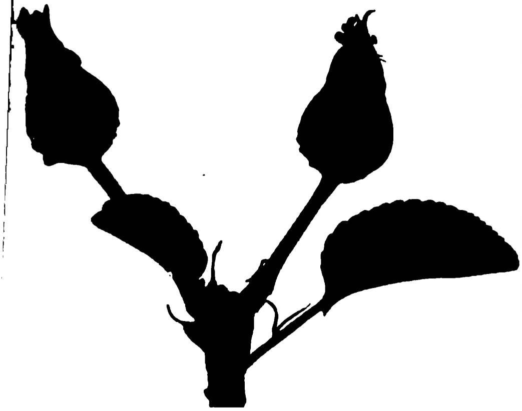


FIG. 99.—*Small apples punctured by Red Bugs, showing drops of gum.*

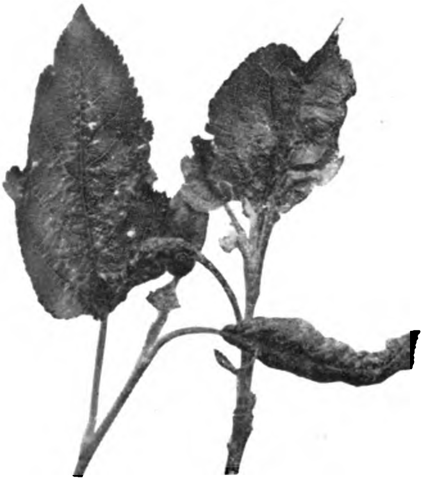


FIG. 100.—*Leaves showing the results of Red Bug work earlier in the season.*

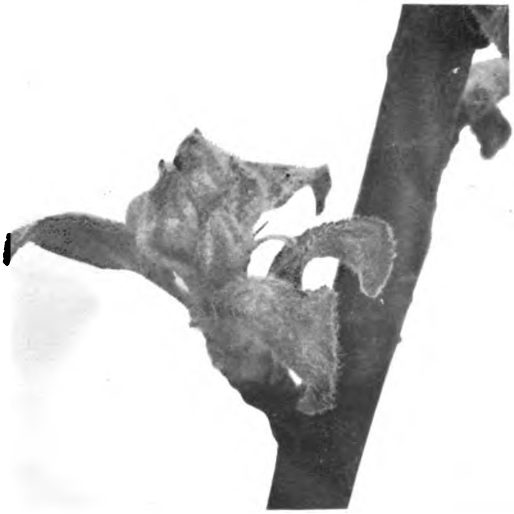


FIG. 101.—*Condition of blossom buds when Red Bug nymphs first appear.*

### DISTRIBUTION

Both species are generally distributed throughout the apple-growing section of New York. Reuter reports the Red Bug from Glen Ellyn, Ill., and Colden, N. Y. We have reared both species from apple twigs sent in from the following places in New York: Brockport, Syracuse, La Fayette, Batavia, Waterloo, West Palymra and Albany. Dr. Uhler, in a letter to Prof. Slingerland, states that the insect was studied by Dr. Asa Fitch at Salem, N. Y., but that his observations were never published. The False Red Bug is recorded by Reuter from Hamburg, Gowanda, and Colden, N. Y. Both species appear to be native to America and probably originally fed on the wild thorn.

A species closely related to the Red Bug occurs in Japan where it is known as the Ringokuragama (*Heterocordylus flavipes* Matsuma). Mr. I. Nitobe has given an interesting account of its habits in The Insect World, Vol. X, No. 1, Jan., 1906. The following is a free translation of a part of his paper which is in Japanese. "The eggs hatch right after the bursting of the buds. At first the nymphs puncture the young leaves and stems and feed on the sap. During the season of blossoming they gather on the flowers and later on the young and immature fruits. When the skin of the fruit becomes hard they return to the leaves which they injure considerably. If two or three insects gather on a leaf the development of the leaf is disturbed; in case of four or five insects the development of the leaf is entirely stopped. The parts of the leaf that are bitten never recover and remain curled. The portion of the fruit punctured remains undeveloped and thus the fruit is deformed."

From the fact that this Japanese insect belongs to the same genus as our American Red Bug and from their close similarity in habits we at first thought they were probably identical, but Mr. T. Shiraki, Government Entomologist of Formosa, who examined our specimens pronounces them distinct.

### FOOD PLANTS

We have never found either species of Red Bug feeding on anything but apple, but Dr. E. P. Van Duzee states in a letter that he found the adults abundant on thorn trees where they appeared to be feeding on Aphids.. This last spring we brought in branches from a large number of thorn trees but failed to rear a single Red Bug from them. Mr Nitobe states that in Japan their species occurs on the pear as well as on the apple.

## PART II. METHODS OF CONTROL

By C. R. Crosby and C. S. Wilson

The Red Bugs are sucking insects; they do not feed by chewing portions of the plant but suck the sap through the tube formed by the four slender bristles of the beak. For this reason it is impossible to kill them by poisoning their food with an arsenical spray. Such insects can be controlled only by sprays which kill by contact.

No attempts were made to kill the adults since they are relatively few in number and at the time of their appearance the trees are in full foliage, making it practically impossible to hit them.

The eggs are so inserted in the bark that the embryo developes some distance from the surface where it is impossible to destroy them by any application to the bark. Knowing that just at the time of hatching the nymphs are very delicate and tender, we tried to kill them by coating the bark thoroughly with the lime-sulfur wash just before the time of hatching. Two trees of Greenings in the midst of a badly infested orchard were chosen for this purpose. They were sprayed April 24th with commercial lime-sulfur, diluted 1 to 8. The experiment was unsuccessful, as the nymphs appeared on these trees as abundantly as on those not treated.

Prof. Slingerland (Proc. N. Y. State Fruit-Growers' Association, 1909, p. 123) suggested that the Red Bug nymphs might be controlled with a strong soap or kerosene emulsion spray applied just before the blossoms open. In 1909 experiments along this line were conducted in three orchards, but owing to the destructive outbreak of the Apple Aphis and to other causes no definite conclusions could be drawn from them. We learned, however, that the nymphs are very hard to kill with either whale-oil soap or kerosene emulsion and that commercial whale-oil soap is very likely to burn young apple foliage.

In 1909 a few small experiments were made against the young nymphs, using commercial lime-sulfur diluted 1 to 30. None were killed unless the liquid was applied so freely as practically to drown them.

In 1910 we repeated these experiments on a larger scale, using whale-oil soap and nicotine preparations.

*Whale oil soap.*—Whale oil soap is really a fish oil soap, but as the older name is retained by the manufacturers it causes less confusion to speak of it by that name. To determine the amount of burning caused by whale oil soap when applied to very young apple foliage, tests were made with three brands of the commercial product. In each case there was more or less injury, but with only one brand was it severe. Dr. L. L. Van Slyke (Geneva Bulletin No. 257, 1904) has shown that the burning of foliage by whale oil soap is caused by the presence of an excess of free or uncombined alkali. We wrote to several soap manufacturers asking for samples of whale oil soap free from uncombined alkali but were unable to obtain it. One firm replied that whale oil soap is a resultant by-product and therefore not uniform in strength and that the amount of alkali must vary with the conditions met with in making. Another wrote, "manufacturing the product commercially, it is impossible to eliminate the free alkali." This seemed strange in the light of Dr. Van Slyke's work in making whale oil soap at home. In order to try it ourselves, we bought the necessary material and made 20 pounds, following Dr. Van Slyke's directions. We found it a very easy and simple operation, and that the soap was practically free from uncombined alkali and was considerably less expensive than that on the market. When tested on young apple foliage in comparison with the commercial brands the home-made soap caused no burning whatever. These tests were made soon after the buds opened and just before the proper time to spray for the Red Bug nymphs. While this home-made soap was safe to use on the foliage, neither it nor any of the commercial brands were effective in killing the nymphs.

*Nicotine preparations.*—Failing to get satisfactory results from the use of either kerosene emulsion or whale oil soap, we tried certain tobacco preparations. In our preliminary experiments we used "Black-leaf," "Nico-fume" and "Black-leaf 40," and found them effective at the following strengths: "Black-leaf" diluted 1 to 65, "Nico-fume" diluted 1 to 700, and "Black-leaf 40" diluted 1 to 816. In later experiments which were conducted on a larger scale, we used only the "Black-leaf" and "Black-leaf 40." Both proved effective at the strengths indicated above when once the nymphs were thoroughly wet with the spray. Following a suggestion of Prof. C. P. Gillette (Jour. Ec. Ent., III, p. 210), we found that the addition of about two pounds of soap to each 50 gallons of the liquid made it spread better and that in a measure it lost its tendency to collect in small drops without wetting the insect.

Mr. D. B. Weaver of Waterloo, N. Y., whose orchard was badly infested by Red Bugs, used "Black-leaf" at the rate of 1 gallon in 100 gallons of dilute lime-sulfur to which arsenate of lead had been added, and reports excellent results in the control of the Red Bugs. This combination has not been tried on a large scale, but this experiment shows that it may be of great value, since in this way a separate spraying for the Red Bugs could be avoided.

Laboratory experiments have shown that when "Black-leaf 40," which has a strongly acid reaction, is added to the dilute lime-sulfur a considerable amount of greenish precipitate is produced. It is not known whether or not this reaction lessens the fungicidal value of the lime-sulfur, but the formation of the precipitate may be avoided by using either "Black-leaf" or "Nico-fume," both slightly alkaline solutions. To determine the relative insecticidal value of these combinations further field experiments are necessary.

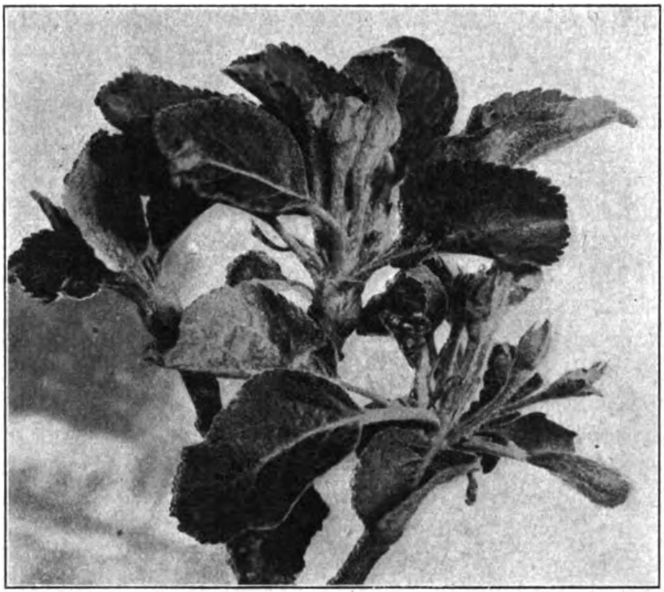


FIG. 102.—*Time for first application for Red Bugs.*

### HOW TO SPRAY FOR THE RED BUGS

The results of our experiments show that the young nymphs may be killed by an application of "Black-leaf" tobacco extract diluted 1 to 65, or "Black-leaf 40" diluted 1 to 800—that is, about 1 ounce in 6 gallons of water or ½ pint in a barrel of 50 gallons. The efficiency of this spray is increased by the addition of about 2 pounds of soap to each 50 gallons.

The majority of the eggs of the Red Bug hatch after the opening of the leaves of the fruit buds and before the blossoms open. The condition of the foliage at this time is shown in Fig. 101. The first application should be made just before the blossoms open and while the nymphs are small, soft, and tender. The condition of the blossoms and foliage at this time is shown in figure 102. This is also the proper time for making the first application for apple scab. The foliage at this time is not so far developed as to give them as much protection as is the case if the spraying is deferred until after blossoming. As the eggs of the False Red Bug and some of those of the Red Bug hatch during the time the trees are in blossom, a second application may sometimes be necessary just after the blossoms fall. At this time the tobacco preparation may be added to the lime-sulfur and arsenate of lead as used for Apple Scab and the Codling Moth.

In spraying for these insects, the greatest thoroughness is necessary. We must remember that the spray kills by contact only and that to get satisfactory results we must hit each insect with enough liquid to wet it thoroughly. A general spray directed at the whole side of the tree will leave many parts untouched. A good plan to follow is to spray the tree branch by branch, starting at the top and following each branch down towards the trunk. Use a fairly coarse nozzle with moderate pressure, that is, 100 to 120 pounds. In case the nicotine is used in dilute lime-sulfur it is necessary that a finer nozzle be used and that care be taken not to drench the trees.

In conclusion we wish to thank Mr. Judson N. Knapp of Syracuse, Mr. B. H. Henion of Brockport, Mr. D. B. Weaver of Waterloo, and Mr. L. B. Frear of Ithaca for their kind co-operation in conducting the experiments located in their orchards.

# CORNELL UNIVERSITY AGRICULTURAL EXPERIMENT STATION.

---

**THE FOLLOWING BULLETINS ARE AVAILABLE FOR DISTRIBUTION TO THOSE RESIDENTS OF NEW YORK STATE WHO MAY DESIRE THEM.**

121 Suggestions for Planting Shrubbery.
136 Chrysanthemums.
139 Third Report upon Japanese Plums.
141 Powdered Soap as a Cause of Death among Swill-Fed Hogs.
147 Fourth Report upon Chrysanthemums.
148 Quince Curculio.
154 Table for Computing Rations for Farm Animals.
168 Studies and Illustrations of Mushrooms: II.
171 Concerning Patents on Gravity or Dilution Separators.
188 Spray Calendar.
189 Oswego Strawberries.
190 Three Unusual Strawberry Pests and a Greenhouse Pest.
192 Further Experiments Against the Peach-Tree Borer.
195 Further Observations Upon the Ropiness in Milk and Cream.
207 Pink Rot an Attendant of Apple Scab.
219 Diseases of Ginseng.
220 Skimmed Milk for Pigs.
225 Bovine Tuberculosis.
234 The Bronze Birch Borer.
240 The Influence of Mushrooms on the Growth of Some Plants.
250 Bovine Tuberculosis
251 Plant-Breeding for Farmers.
254 Drainage in New York.
255 Bean Anthracnose.
256 Street Trees, Their Care and Preservation
257 Defects in American Cheddar Cheese.
258 Moulting of Fowls.
262 Apple Orchard Survey of Niagara County.
265 Certain Seed-Infesting Chalcis-Flies.
266 The Black Rot of the Grape and Its Control.
267 Fertilizing and Seeding Experiments with Root Crops.
270 Fancy Cheese for the Farm and Factory.
272 Fire Blight of Pears, Apples, Quinces, etc.
273 The Effect of Fertilizers Applied to Timothy on the Corn Crop Following it.
276 Peach-Leaf Curl.
278 Classification of the Peony. Third Report.
281 Butter Moisture-Tests.
282 Seven Methods of Feeding Young Chickens.
283 The Control of Insect Pests and Plant Diseases.
284 Labor-Saving Poultry Appliances.
285 Cause of "Apoplexy" in Winter Fed Lambs.
286 Snow White Linden Moth.
289 Lime Sulphur as a Summer Spray.

Address, COLLEGE OF AGRICULTURE,
ITHACA, N. Y.